Voyages to the Terrestrial Planets: *Comparing Ares Valles Mars to the Mississippi River of Earth*
This activity is modified from one created by Dr. Eric Grosfils, Pomona College

Overview: Today we are going to carry on with our analysis of surface processes that may have operated on Mars. Specifically, we are going to compare a potential river channel on Mars with one of the most famous river systems on Earth, the Mississippi River. The purpose of this lab is two-fold. First, it is meant to have you become familiar with processes we predict have operated on Mars and, second, it is meant to give you an appreciation of how we talk about and analyze rivers on Earth. By the end of this assignment, you will be able to explain some of the evidence for water flowing on Mars, calculate discharge, and qualitatively interpret images of a planetary surface.

Due: This is due with your next homework log at the time of your second midterm.

To do: You will need to use both JMars and Google Earth for this assignment.

Part 1: Identifying river systems

Map 1

1) Examine the image labeled 'Map 1'. This is a shaded relief image of Mars highlighting Ares Vallis and channel systems that have fed into it. Identify the channels that feed into Ares Vallis and label them on the image.

2) On Map 1, trace out a rectangle that encompasses Ares Vallis and its tributaries. Using either the scale on the map or JMARS, measure the length of your lines. Record the lengths on the image.

3) Using those lines, calculate the area that Ares Vallis ultimately drains. You are essentially calculating the area of a rectangle. So your calculation should be length times width (or one side multiplied by the other). Show your work and answer in the space below.

Map 2

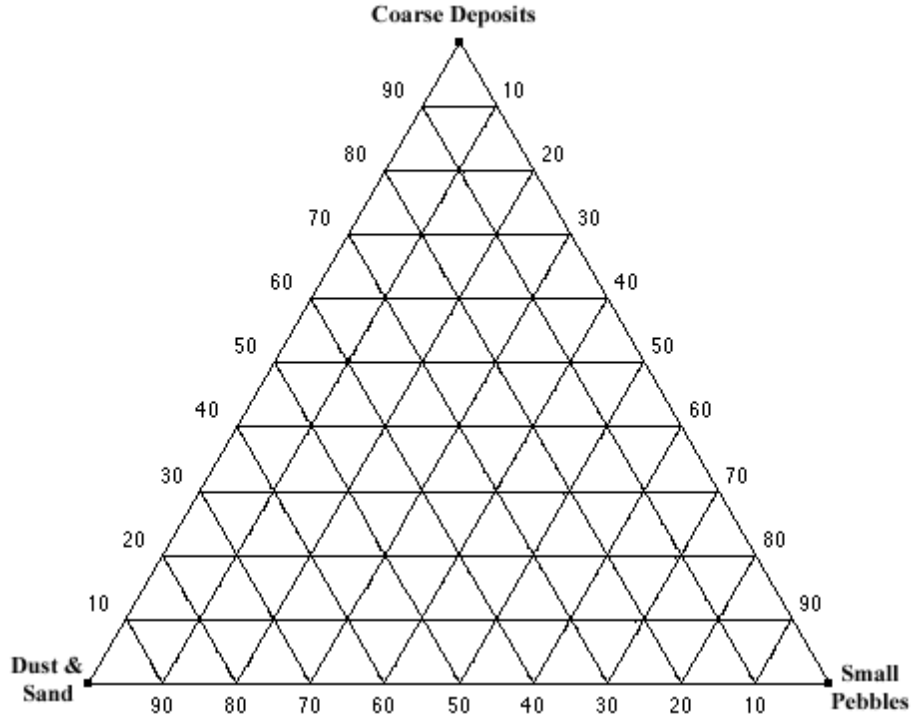
1) Examine the image labeled 'Map 2'. This is a Google Earth image of much of the United States and emphasizes the Mississippi River, which drains the middle portion of our country. Identify the Mississippi River and the rivers that drain into it and label it on the image.

2) On Map 2, trace out a rectangle that encompasses the Mississippi River and its tributaries. Using either the scale on the map or Google Earth, measure the length of your lines and record those values on the image.

3) Using those lengths, calculate the area that the Mississippi River drains. Show your work and your answer in the space below:

Part 2: Calculating Discharges of the river systems

1) Using images taken by the lander's camera (see below) as well as thermal remote sensing satellite data, it has been estimated that the surface of the landing site and immediate vicinity is best described as: 16% semi-rounded large pebbles, cobbles and boulders (>3 cm and <7 m is the range observed, but some/all of these could also be derived from impact events), 25% small pebbles and lag deposits (deposits formed when wind removes fine particles, leaving coarser grained material behind), and the remaining 59% is covered with sand and dust. Using these data, plot the Pathfinder site mixture on the Ternary diagram below.



Ternary diagram.

2) Using the image below of the Pathfinder site and the materials description provided above, provide a reasoned, well-supported explanation for what you estimate as the water velocity necessary to carry the *average* sized detrital particles to the Pathfinder site where they were deposited. Be sure to document your work, showing for instance how you calculated the average size fraction, etc. A range of answers will be accepted provided that the reasoning and support for your argument are well laid out, quantitative where possible, and self-consistent. You will need to use the Hjolstrom diagram below to help you calculate your water velocity.

3) In JMARS, draw a topographic profile across a northern part of Ares Vallis and record in the space below the width and depth you have measured (you can select wherever you would like across the channel, but make sure you are going across the channel). Ares Vallis is located at ~10°N, 338°E. To do this part you will need to add the topographic layer into JMars. To do this, click on 'Add New Layer' on the main menu. Then, under 'Select Category', click on 'Surface Properties' and then as a sub-property, choose 'Topography'. Next, in the lower portion of the 'Add a new layer' window, click on 'Elevation' and select 'MOLA 128ppd Numeric Elevation'.

4) Based on those measurements of depth and width, use the average water velocity you estimated from above to calculate the discharge of Ares Vallis. Make sure to show your work below.

5) Using Google Earth, fly to where the Mississippi River enters into the Gulf of Mexico and measure the river's width. At this spot the river is about 50 feet deep and travels at an average velocity of ~3 feet/second. Based on these values, what is the average discharge of the Mississippi River? Make sure to show your work and answer below.

Bringing it together – *Turn this in with your homework log*:

1) How does the length and drainage basin area of Ares Vallis compare to the Mississppi River? Does what you observe seem reasonable? Explain.

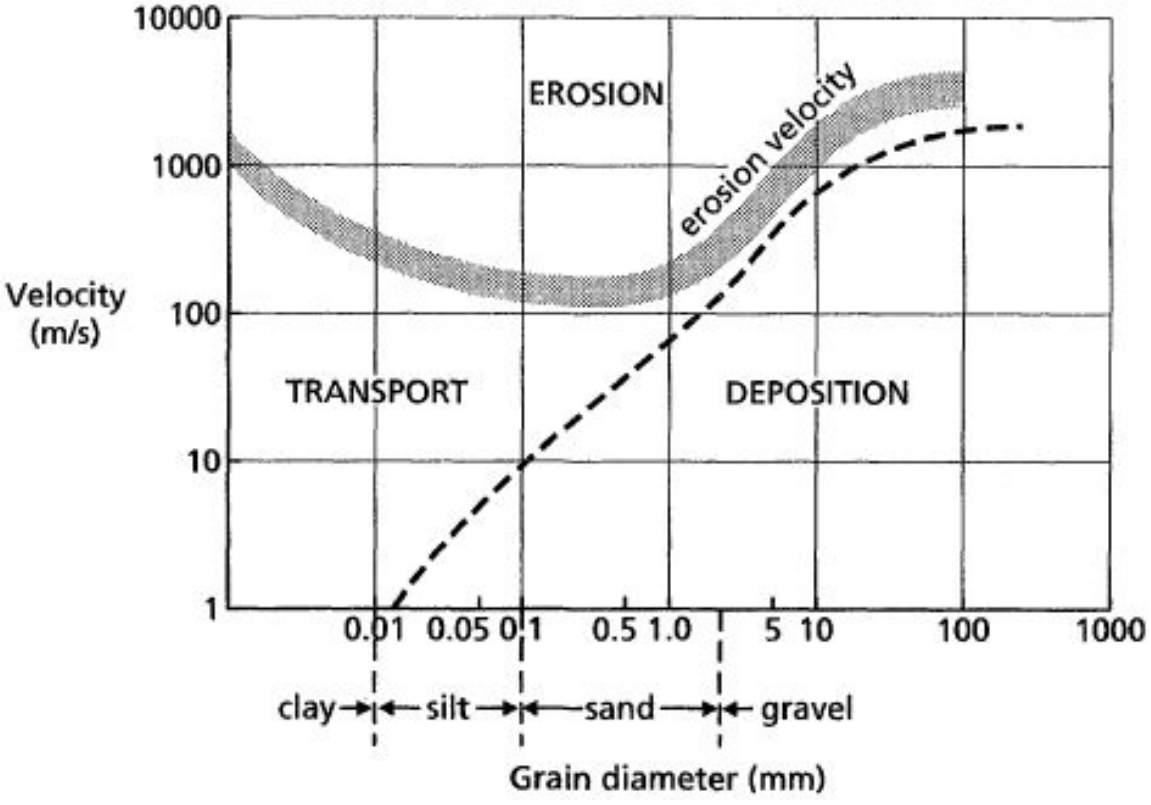
2) How does the amount of water that came out of Ares Vallis compare to that for the Mississippi River?

3) What assumptions have we made about Ares Vallis that could distort our results? What other pieces of information would you like to be more sure of to make the calculations you did for Ares Vallis?

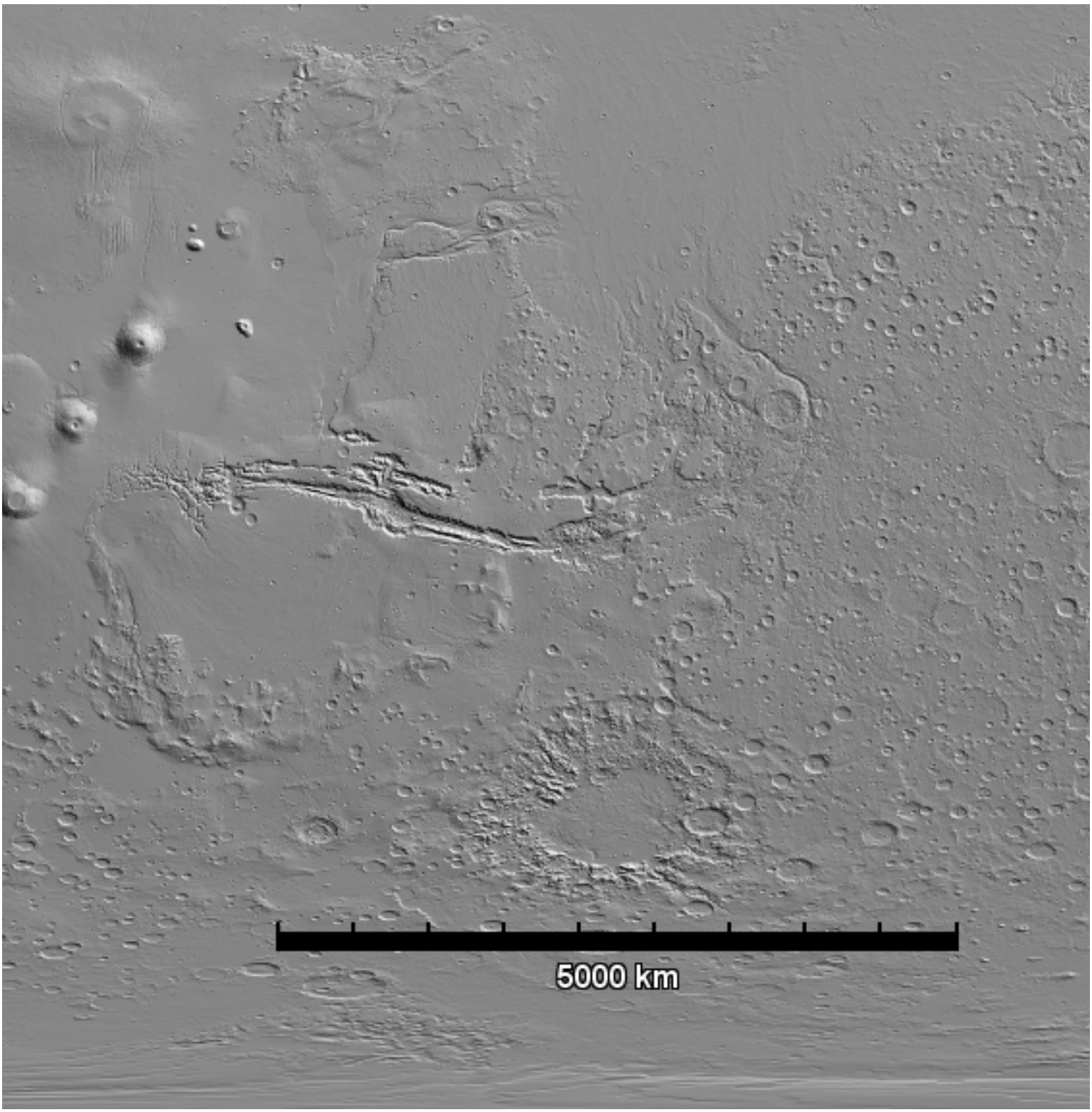
4) Where would the water from Ares Vallis go to on Mars? What are the implications of where that water would end up?

5) Several groups of scientists have attempted to estimate the discharge rates for Ares Vallis and the other channels which appear to drain into the northern lowland plains. This is not simply an academic exercise, as the volume of water which the channels can disgorge can be compared directly with the volume of water required to fill the purported northern ocean on Mars. This comparison is ongoing. For Ares Vallis, peak discharge estimates are approximately 7×10^{7} m^{3}/s. Explain why you feel your answer does or does not support this value – if your answer is different, what factors might we have failed to consider (and what influence would you expect this to have?), and if your answer is similar to the one provided above, do you believe it – why or why not? Please attach an additional page if necessary.

Image of the Pathfinder landing site in Ares Vallis. Large rocks in the foreground are 30-40 cm across.



Hjolstrom diagram.



Map 1


Rocky Mountains
Lake Superior
Lake Huron
Georgian Bay
Lake Michigan
Lake Ontario
Lake Erie
Ottawa
Gulf of St Lawrence
Saint Pierre and Miquelon
Saint-Pierre
Bay of Fundy
United States
Appalachian Mountains
Washington
Bermuda
Gulf of California
1083 mi
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Google
Image © 2012 TerraMetrics
US Dept of State Geographer
38°37'03.02" N 89°57'11.24" W elev 519 ft
Google earth
Eye alt 2891.62 mi

Map 2

Ares Vallis topographic profile